	inches.
Length, forearm	1·6
,, thumb	0·35
,, third finger, metacarp.	1·5
,, ,, ,, 1st ph.	0·5
,, ,, ,, 2nd ph.	0·8
,, ,, ,, 3rd ph.	0·5
,, fourth finger, metacarp.	1·45
,, ,, ,, 1st ph.	0·4
,, ,, ,, 2nd ph.	0·55
,, fifth finger, metacarp.	1·25
,, ,, ,, 1st ph.	0·35
,, ,, ,, 2nd ph.	0·5
,, tibia	0·55
,, foot	0·38

ARTIBEUS QUADRIVITTATUS, Ptrs. Popayan.

CHIRODERMA SALVINI, Dobson. Popayan.

An adult male specimen of this species, with faintly marked facial streaks, and a very narrow white line in the fur along the lower half of the spine. This shows that the white streaks are as variable in this species as I have already noticed in the case of *Artibeus planirostris* (Catal. Chirop. Br. Mus. p. 516). The important structural characters on which the species depends are, however, as well marked in the only specimen hitherto known (the type, in the collection of the British Museum), which was collected by Mr. Salvin in Costa Rica, and named by me after the discoverer.

EXPLANATION OF PLATE XLVI.

Fig. *a*. *Megaderma gigas*, natural size.
b. Skull of *Megaderma gigas*.

3. On the Anatomy of *Leptosoma discolor*.

By W. A. FORBES, B.A., F.L.S., Prosector to the Society.

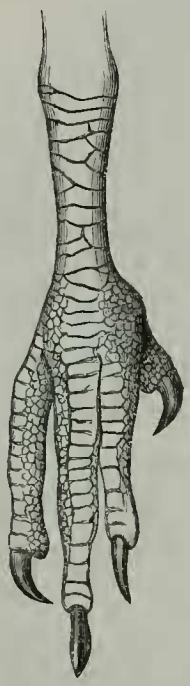
[Received May 28, 1880.]

It is to the liberality of my friend Prof. A. Newton that I am indebted for the opportunity of dissecting a female example of this bird, the most peculiar, perhaps, with the exception of *Mesites*, of all the anomalous forms that Madagascar produces. Till the past year or two our knowledge of the structure of *Leptosoma* was almost confined to its skin and certain parts of its skeleton.

Mr. Sclater, in this Society's 'Proceedings' (1865, pp. 682–689; also in Nitzsch's 'Pterylography,' Ray Soc. ed. App. ii. p. 158) has already given us an account of the different views that have at various times been held by ornithologists as to the position of this peculiar form; and he was also the first to point out the existence

in it of powder-down patches, as well as other of its peculiarities. Since then I am unaware of any thing more having been done to elucidate its structure till 1878. In M. Grandidier's magnificent work on Madagascar[1], in the plates of the Atlas devoted to the birds, M. A. Milne-Edwards has figured the entire skeleton, together with separate views of the bones, as well as the tongue and alimentary canal, and has likewise given pictures of the bird when plucked, showing the external nares, the position and shape of the powder-down patches, and its naked oil-gland. In reply to my inquiries on the subject, M. Milne-Edwards kindly replied that he intended to describe in full the osteology of *Leptosoma*, together with that of *Atelornis*,

Fig. 1.



Right foot of *Leptosoma* (nat. size), seen from before, to show the disposition of the toes. (The fourth toe is slightly removed outwards, to better show its position.)

Brachypteracias, &c., of which figures are given also in the above-named work, in the text, but that, as regards other points, only an explanation of the plates was to be given. I have therefore thought it would be of interest to bring before the Society some additional notes on its pterylosis and soft parts, derived from my examination of Prof. Newton's specimen.

Before proceeding further, I should like to call attention to the structure of the feet in *Leptosoma*, which has already been accurately described by Mr. Sclater (*l. c.* p. 688). They are in no way "zygodactyle," in the sense in which that term is applied to the feet of such

[1] Hist. Phys. nat. et pol. Madag., Zool., Ois. pls. 85–88.

birds as the Cuckoos, Parrots, or Toucans. In this spirit-preserved specimen it is easily demonstrable that the fourth digit cannot naturally be placed in a really reversed position, like that of the above-named birds. While the second and third toes look directly backwards, the hallux looks inwards and forwards, and the fourth toe *inwards* and slightly *backwards* at its apex, there being, as it were, a slight twist in its axis[1]. However much the fourth toe is bent backwards (and this is only done by the exercise of some little force), its plantar surface always looks more or less inwards. The presently-to-be-described arrangement of the deep plantar tendons also confirms the view here taken as to *Leptosoma* not being a true zygodactyle bird.

Pterylosis.—As regards *Leptosoma*, Nitzsch only noted the presence of an aftershaft and 12 rectrices, he only having been able to examine a stuffed specimen. Mr. Sclater, in his above-mentioned paper, besides describing the two characteristic lumbar powder-down patches of this bird, briefly alludes to the pterylosis, which "appears nearly similar to that assigned by Nitzsch to *Coracias* and *Eurystomus*." These features are diagrammatically represented in a woodcut (fig. 5, *l. c.*).

The following is a more detailed description :—

The inferior tract divides about 1 inch behind the junction of the rami of mandible—the (badly) so-called "chin-angle"—from which it starts as a narrow, single tract[2]. Between this tract and the mandibular rami, extending as far as the angle of the jaw, a narrow naked space is left; at this point the inferior tract becomes continuous with the feathering of the head above, so that here the neck, except for the narrow median ventral *apterium*, is continuously feathered. This continuous feathering extends downwards till about $\frac{3}{4}$ inch above the shoulder, when, the inferior and dorsal tracts diverging, the lateral neck-space is formed. The inferior tracts diverge gradually as they approach the breast, and then run parallel to each other over the pectoral muscles and abdomen to the sides of the vent, leaving a rather wide bare carinal space, with a few scattered down-feathers. As the inferior tract emerges on the breast, it gives off a branch to the anterior margin of the *patagium*; and this at first is dilated somewhat, so that the space between it and the main tract is feathered. The broad humeral tract is also connected with the inferior tract where the latter gives off this patagial branch. In the lower part of the neck the inferior tract is about 8 feathers broad, on the breast about 6, and on the abdomen only 2. About the middle of the sternum the outer pectoral tract, which is about 4 feathers wide and slightly stronger than the main tract, is given off; it is

[1] This disposition of the fourth toe makes *Leptosoma*, at first sight, look as if it had three toes anteriorly directed, and no doubt accounts for Mr. Sharpe entirely omitting any notice of its peculiar feet in his paper on the Coraciidæ (*cf.* Ibis, 1871, pp. 187, 285).

[2] In *Coracias garrula* the naked median space left between the halves of the inferior tract extends quite up to the symphysis, so that the inferior tract is double from the commencement.

not very divergent, but is dilated terminally, and develops a recurrent hook, which, however, is not very distinct. There is a circlet of feathers round the vent, and a short tract of feathers behind it, on each side of the fleshy part of the tail, continuing the direction of, though quite separate from, the main inferior tract of its side.

The feathering of the head above is continuous, and from it the anterior moiety of the dorsal tract runs, being anteriorly continuous at the sides, as already noted, with the inferior tracts, along the dorsal median line of the neck, as a rather broad, thickly feathered band, which forms a strong interscapular fork, just as in *Coracias* and the Parrots, the ends of the fork lying about $\frac{1}{4}$ inch anterior to the posterior extremities of the two scapulæ. The posterior moiety has also a forked form, the two arms enclosing a fairly broad naked median space, and only uniting about 1 inch in front of the oil-gland, the united tract so formed ceasing altogether about $\frac{1}{4}$ inch in front of that organ. This posterior fork is very narrow anteriorly, not more than two feathers wide; indeed, for the first two or three rows each arm consists of only one feather in each row, and the two arms run in between the forks of the anterior moiety, just as in the Parrots, *Coracias*, and some other birds. Posteriorly the fork widens, and becomes connected closely with the scattered contour-feathers which are found outside it, over the space between the dorsal tract proper and the lumbar powder-down patches, so that on the rump the dorsal tract appears to consist of five or six rows of feathers on each side of the median line. There is a very strongly feathered and broad band of feathers over the knee, being the anterior end of the lumbar tract of its side; this tract is quite distinct from all others but the crural, which are much weaker and clothe the leg as far as the "ankle." The powder-down patches, one on each side, lie between the posterior portion of the dorsal tract and the lumbar tracts. They form elongated patches, extending forwards over the femur as far as the *sartorius* muscle, and backwards to within $\frac{1}{4}$ inch of the vent; their dorsal border is parallel to the dorsal tract, the ventral to the lumbar ones. On the inside of the skin they are conspicuous as dark grey patches, formed by the closely aggregated insertion of the feathers of which they are composed, these lying at a less angle with the skin than the contour-feathers. Nitzsch[1] has described the pterylosis in *Coracias garrula* and *C. indica*, with figures of that of the former, and in *Eurystomus gularis*. I have examined the first-named species in the flesh, and also a skin of *Atelornis crossleyi*. In all essential respects, as will be seen by a comparison of the above description with Nitzsch's figures of *Coracias garrula*, *Leptosoma* is essentially Coraciine, though it differs from all others of that group in its possession of powder-down patches[2].

[1] Pterylogr. (Ray Soc. ed. p. 89).

[2] I may here mention that *Atelornis crossleyi* differs as regards its pterylosis but slightly from the Coraciine type. It has the same interrupted dorsal tract, each half having a furcate form; but here the interscapular fork is very short and narrow, and does *not* enclose the anterior part of the posterior fork,

In the Cuculidæ the dorsal tract, though it divides between the shoulders, is perfectly continuous throughout, enclosing an elongated oval space (*vide* Nitzsch's figures of *Cuculus canorus* and *Centropus rufipennis*, *l. c.* pl. iv. figs. 12 & 14). In the Cuculidæ too, as is well known, the aftershaft is absent and there are but 10 rectrices. I may remark that in the possession of an *inter*scapular dorsal fork the Coraciidæ and *Leptosoma* form an exception to Prof. Garrod's generalization[1] that when "the dorsal tract develops a fork *between* the shoulder-blades a bird is homalogonatous."

Visceral Anatomy.—The mucous membrane of the palate and mouth is smooth throughout, except along the margins of the nasal aperture, where it develops three or four small blunt retroverted tubercle-like papillæ on each side, and also external to this on each side along a line parallel to the axis of the palatine bones, where there is a similar short row of small papillæ.

The tongue is tapering and elongated in shape; its length is $1\frac{1}{4}$ inch. The basal part, which alone is fleshy, and supported by the hyoid bones, is of a triangularly sagittate shape, about $\frac{1}{2}$ inch long, and provided at its postero-external angles with a few minute, blunt, retroverted papillæ; it is prolonged forwards into a horny lamina, which is strongly concave above and forms the greater part of the tongue; at its apex the part, which is of a slightly tapering shape, is apparently entire[2]. This tongue closely resembles that of *Coracias*, and differs from that of such of the Cuculidæ as I have examined in wanting the well-developed retroverted spines that are always present on the posterior part of the lateral margins in those birds[3].

The œsophagus is capacious at first, but rapidly narrows; it develops no crop. The proventriculus is zonary, being $\frac{1}{2}$ inch deep. The stomach is globose and not strongly muscular; there is a distinct pyloric bulb indicated externally at the commencement of the duodenum. Internally it is lined with rather soft epithelium, which is concentrically striated. In the present example the stomach contained hairs, apparently of lepidopterous larvæ, and the horny jaws and other hard parts of insects; many of the smaller hairs had become impacted in the soft lining of the stomach, so that this at first sight appeared to be villous. The same appearance has often been described in our common Cuckoo[4].

The intestines in all measure $12\frac{1}{2}$ inches, of which $2\frac{3}{4}$ are "large;" they are not markedly capacious. The cæca[5] are long and cylindri-

---

which has a long stem or "handle." There are the same strong lumbar tracts. Below, the outer pectoral tract, given off on the middle of the breast, is only indicated by an enlargement of the main tract, and is not at all free. There are no traces of powder-down patches.

[1] P. Z. S. 1878, p. 931.

[2] The tongue of *Leptosoma* has been figured by Mr. Sclater (*l. c.* p. 688), and also by M. A. Milne-Edwards (*l. s. c.* pl. 88. fig. 1).

[3] *Vide* also the figures of the tongues of *Coua gigas* (pl. 63. fig. 1) and *C. olivaceiceps* (pl. 64. figs. 1, 2) in Grandidier's work.

[4] *Cf.* Hunter's Essays and Observations, ii. p. 285 &c.

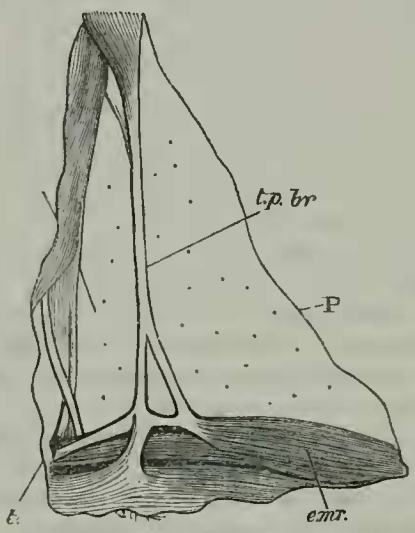
[5] Figured, with other parts of the intestinal canal, by M. Milne-Edwards, *l. c.* pl. 88.

cal in shape, largest apically, and slightly tapering towards their bases; they measure respectively $2\frac{1}{4}$ and $2\frac{3}{4}$ inches. The liver has the left lobe much the smallest; there is a distinct gall-bladder.

There is thus nothing striking or characteristic about the alimentary canal. In the possession of large cylindrical cæca, *Leptosoma* agrees with both Coraciidæ (including *Brachypteracias* and *Geobiastes*) and Cuculidæ, as also in most of the other points noted. In the Cuckoos, however, the gall-bladder is *said* to be absent as a rule[1].

Myology &c.—The first pectoral is big; the second extends

Fig. 2.



Wing-muscles of *Leptosoma*.

Termination of the *tensor patagii brevis* (*t.p.br.*) in *Leptosoma*. *e.m.r.*, the fleshy belly of the superficial layer of the *extensor metacarpi radialis longior* muscle; *t*, the tubercle on the humerus, whence it arises; above it the humerus. P, the *patagium*, its dorsal layer having been removed to show the muscles, &c.

at least halfway down the sternum; the third is not represented. There is no *biceps*-slip to the patagium, as is the case in all "Anomalogonatæ" except the Caprimulgidæ. In none of these points does *Leptosoma* differ from the Coraciidæ or Cuculidæ. The *expansor secundariorum* is present and well developed; its proximal end is T-shaped ("*ciconiiform*," Garrod), the sternal part of the tendon being attached to that bone at the junction of the costal process with the body near the coracoid groove; it therefore resembles

[1] Owen, Anat. Vert. ii. p. 177. Gadow also states its absence in *Cuculus*. Hunter, on the other hand, found it, though "very small," in *C. canorus* (*l. s. c.* p. 285). According to the plates in Grandidier's work, *Coua gigas has* a gall-bladder (pl. 63); so has *Geobiastes squamigera* (pl. 99. fig. 2).

the same muscle in the Coraciidæ. In no other birds amongst the Anomalogonatæ is this muscle present. In the Cuculidæ this muscle is present, but its terminal tendon is *not* T-shaped, the sternal moiety being undeveloped.

The arrangement of the termination of the *tensor patagii brevis* is represented in the accompanying figure (fig. 2, p. 470).

The main tendon (*t.p.br.*) runs on to the ulnar side of the arm, and there becomes fused with the fascia covering the muscles. Before doing so, however, it crosses the superficial tendon of origin of the *extensor metacarpi radialis longior* (*e.m.r.*), which springs from the humeral tubercle, and becomes firmly blended with it.

It likewise sends off, distally, a special slip of tendon which joins the same tendon of that muscle more externally (wristward). This is much the same arrangement as in the Coraciidæ, as described and figured by Prof. Garrod (P. Z. S. 1876, p. 511, pl. 49. fig. 1), except that in those birds the tendon of the *tensor patagii brevis* is split into two quite separate halves; if these were united together, an arrangement would be arrived at practically identical with that of *Leptosoma*. In the Cuculidæ the condition of things is quite different, as in them the "undivided tendon runs on to the ulnar superficial fascia without any complication" (*l. c.* p. 512).

Of the leg-muscles, the *gluteus primus* is present, though small, only slightly overlapping the *biceps*, and with its fleshy part not reaching the innominate, to which it is attached only by fascia. The *ambiens* is absent; the *femoro-caudal* is very large, but lacks the accessory head, as in all Anomalogonatæ. Both the *semitendinosus* and its accessory are well developed, as is the *semimembranosus*. The *biceps cruris*, as usual, passes through a tendinous loop. The *obturator externus* is well developed, and the *obturator internus* is of a very elongated oval shape. The formula of *Leptosoma* is therefore $-$. A . X . Y, exactly the same as that of the Coraciidæ and the greater number of Anomalogonatous birds. In the Cuculidæ the ambiens is *always* present and well developed, and the *accessory femoro-caudal* usually so[1], giving a formula of $+$. A . (B) . X . Y . *Leptosoma* is therefore clearly *not* Cuculine. In the Cuculidæ, too, the *obturator internus* is triangular in shape, as in the Gallinæ and their allies; in *Leptosoma*, as already stated, as in *Coracias*, it is oval.

The anomalous arrangement of the toes in *Leptosoma* made me very anxious to observe the disposition of its deep plantar tendons, these, in all "zygodactyle" Anomalogonatous birds, being arranged in a manner quite unique amongst birds and entirely different from that which obtains in the even-toed *Homalogonatous* birds (*i. e.* the Psittaci, Cuculidæ, and Musophagidæ)[2].

But in *Leptosoma neither* of these conditions occurs; on the contrary, the disposition of its plantar tendons is exactly that found in many birds with feet of the ordinary structure. This condition is

[1] It is absent only in *Cuculus*, *Chrysococcyx*, and *Cacomantis*. [Garrod's MSS.]

[2] *Vide* Garrod, P. Z. S. 1875, p. 345.

diagrammatically represented in fig. 3; as will there be seen, the tendon of the *flexor longus hallucis* (*f.l.h.*) joins the tendon of the *flexor profundus digitorum* (*f.p.d.*) *on the outer side*, some little way above the phalanges, and completely *blends* with it. From the single compound tendon so formed the small slip to the hallux is given off, on the *inner* side, just before the common tendon splits up for distribution to the three other digits. This is exactly the same condition as that found by Prof. Garrod in *Coracias garrula*, and by myself in *Atelornis crossleyi* (in a skin).

It differs completely from that found in the Psittacidæ, Cuculidæ, and Musophagidæ on the one hand, and that of the Galbulidæ, Bucconidæ, and Picidæ and their allies on the other. Therefore this fact, when taken in conjunction with the statements already made as

Fig. 3.

Diagram of the arrangement of the deep plantar tendons in *Leptosoma*. *f. l. h.*, the *flexor longus hallucis*; *f. p. d.*, the *flexor profundus digitorum*.

to the natural position of the fourth digit in *Leptosoma*, shows that there are no real grounds for calling *Leptosoma* a "zygodactyle" bird [1].

As regards other points, it may be mentioned that the vessels and nerves of the thigh are normal; that is to say, the sciatic nerve and artery and the femoral vein are all present in their normal position.

There are *two* carotid arteries present, both of them being unusually small, the left particularly so. They run up in the usual converging way, springing from the vertebral arteries into the hypapophysial canal of the neck, and there become so closely applied to each other that it is impossible to dissect them away as can usually

[1] In *Podargus cuvieri*, where the outer toe is reversed in perching, and in *Colius*, where the toes are directed at various times in very different ways, the "same blended" distribution of the deep plantar tendons obtains.

be done in birds. As far as I can make out, they do not, however, fuse, but are continued up to the head and there diverge. In *Opisthocomus*[1] Prof. Garrod found a somewhat similar condition, though he says nothing about the vessels being minute. In *Leptosoma* they have the appearance of white fibrous cords, and they may *possibly* be, like the carotids of *Bucorvus*[2], no longer functional as blood-channels. But satisfactorily to decide this, as well as the ultimate termination of these carotids, fresh or injected specimens will be necessary.

In both the Cuculidæ and Coraciidæ there are two equisized carotids, which are as free as usual.

As regards the vocal organs, there are present but one pair of extrinsic muscles, which diverge to be attached to the "costal processes" of the sternum. The syrinx possesses a single pair of

Fig. 4. Fig. 5.

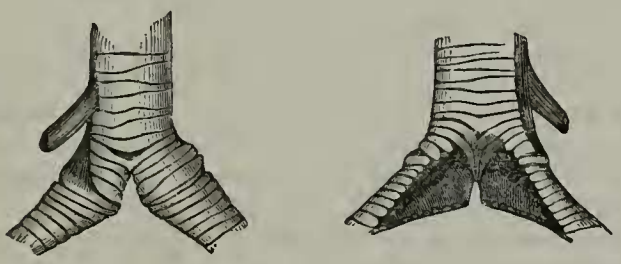


Fig. 4. The syrinx of *Leptosoma* seen from in front, the muscles of the *left* side having been removed.
Fig. 5. The same, from behind. (Both are twice the natural size.)

intrinsic muscles, as usual. This organ having been previously unknown in *Leptosoma*, I here take the opportunity of describing and figuring it.

The tracheal rings, which, as usual, interlock with each other for the greater length of the trachea, are well ossified, and only separated by narrow intervals. They gradually narrow as they approach the thorax, the last two being the narrowest of all. The penultimate tracheal ring is produced downwards in a triangular way behind, as is the terminal one in front; behind, this last ring bears the anteriorly-directed narrow pessulus, which intervenes behind between the inturned ends of the first pair of bronchial semirings, but in front does *not* appear, stopping short before it reaches the anterior surface of the bifurcating trachea.

Like the tracheal rings, the first three bronchial semirings are well ossified, and separated from each other only by very narrow interannular intervals. They are nearly straight, with only a very slight concavity upwards, and increase in depth as they descend. In front the semirings of opposite sides are separated from each other by

[1] P. Z. S. 1879, p. 112.
[2] *Vide* Mr. Ottley's paper on this bird, P. Z. S. 1879, pp. 461–467.

a small notch; behind they are less and less complete as they go downwards. The first semirings are posteriorly closely applied to, though separate from, the pessulus, and are apparently continued on, as cartilaginous rings, posteriorly, so as to form complete or nearly rings. The posterior ends of the second and third semirings where they appear behind are widely separated from their fellows of the other side. The fourth and succeeding bronchial rings are all cartilaginous. Of these the fourth is the largest, being nearly straight, and slightly more prominent than the others. To its middle, rather towards its posterior margin, is attached the (single) intrinsic syringeal muscle. The rings succeeding the fourth ring rapidly become more and more complete, at the same time that the bronchus becomes less capacious, the whole tube tapering away from this ring as it approaches the lung. The fifth and sixth semirings are more slender than those that succeed them, and are slightly concave upwards. The remaining ones are straighter and deeper. Except between the fourth and fifth, and fifth and sixth semirings, the interannular intervals are exceedingly narrow.

This syrinx does not show much similarity of form to that of *Coracias garrula*, the only one of the family of Coraciidæ that I have been able to examine as regards this point. At the same time it does not much resemble that of any Cuckoo I am acquainted with.

Reviewing the facts already stated, it is clear that the affinities of *Leptosoma* to the Cuculidæ are very remote, whilst, on the contrary, its relations to the Coraciidæ are quite the reverse. The subjoined tabular statement of the principal points in the structure of the three just named groups will perhaps render this additionally clear:—

	Tail-feathers.	Aftersh.	Oil-gland tuft.	Ambiens.	Fem.-caud.	Acc. f.-c.	Semitend.	Acc. semit.	Exp. secund.	Obt. int.	Carotids.	Cæca.
Cuculidæ ...	10	−	−	+	+	+	+	+	peculiar	triangular	2	+
Leptosoma...	12	+	−	−	+	−	+	+	ciconiine	oval	2	+
Coraciidæ ...	12	+	−	−	+	−	+	+	ciconiine	oval	2	+

In common with both Cuculidæ and Coraciidæ, *Leptosoma* possesses a nude oil-gland and long cæca, two carotids, and the femorocaudal, semitendinosus, and accessory semitendinosus muscles. Wherever there is any difference, *Leptosoma* resembles the Coraciidæ; and the same story is told by the pterylosis and *tensor-patagii* arrangement.

Nevertheless, both in the syrinx and in these last two points, as well as in some others, especially osteological ones[1], *Leptosoma* is not quite typically Coraciine, and it may therefore be retained, as

[1] *Vide* Grandidier's work, Atlas, Ois. pls. 85, 86.